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<b>TRANSMITTAL LETTER TO THE UNITED STATES          DESIGNATED/ELECTED OFFICE (DO/EO/US)          CONCERNING A FILING UNDER 35 U.S.C. 371</b>		U.S. APPLICATION NO. (if known, see 37 CFR 1.5) <b>09/719452</b>
INTERNATIONAL APPLICATION NO. PCT/JP00/02406	INTERNATIONAL FILING DATES 13 April 2000	PRIORITY DATE CLAIMED
TITLE OF INVENTION VIDEO PROCESSING DEVICE AND METHOD, AND MEDIUM		
APPLICANT(S) FOR DO/EO/US Ikuro TSUKAGOSHI, et al.		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371 2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371. 3. <input type="checkbox"/> This is an express request to promptly begin national examination procedures (35 U.S.C. 371 (f)). 4. <input type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (PCT Article 31). 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c)(2)) a. <input type="checkbox"/> is attached hereto (required only if not transmitted by the International Bureau). b. <input checked="" type="checkbox"/> has been communicated by the International Bureau. c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)). 7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)) a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau) b. <input type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input checked="" type="checkbox"/> have not been made and will not be made. 8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)). 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)). (Unexecuted) 10. <input type="checkbox"/> An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).		
<b>Items 11. to 16. below concern document(s) or information included:</b>		
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. w/PTO-1449, 3 references 12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 & 3.31 is included 13. <input type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 14. <input type="checkbox"/> A substitute specification. 15. <input type="checkbox"/> A change of power of attorney and/or address letter. 16. <input checked="" type="checkbox"/> Other items or information:		
Verification of a Translation Copy of PCT Request (in English) First Page of Published Application (WO/00/62550) Copy of International Search Report (in English & Japanese) Seventeen (17) Sheets of Formal Drawings		

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U.S. APPLICATION NO. <b>097719452</b> (if known, see 37 CFR 1.5)	INTERNATIONAL APPLICATION NO. PCT/JPC/02406	ATTORNEY'S DOCKET NUMBER SONYJP-113
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17. <input checked="" type="checkbox"/> The following fees are submitted: <div style="margin-top: 10px;"> <b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):</b>  <input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO . . . \$1,000.00  <input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO . . . \$860.00  <input type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO . . . \$710.00  <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) . . . \$690.00  <input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) . . . \$100.00         </div>	<b>CALCULATIONS</b> PTO USE ONLY <div style="border: 1px solid black; height: 100px; width: 100%;"></div>
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<b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>	<b>\$860.00</b>
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Surcharge of **\$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	13 - 20 =		x \$18.00	
Independent claims	5 - 3 =	2	x \$80.00	\$160.00
MULTIPLE DEPENDENT CLAIM(s) (if applicable)			+ \$270.00	
<b>TOTAL OF ABOVE CALCULATIONS =</b>				<b>\$1,020.00</b>

☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.

<b>SUBTOTAL =</b>	<b>\$1,020.00</b>
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Processing fee of **\$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +

<b>TOTAL NATIONAL FEE =</b>	<b>\$1,020.00</b>
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Fee for recording the enclosed assignment (37 CFR 1.21 (h)). Assignment must be accompanied by appropriate cover sheet (37 CFR 3.28, 3.31) (+ \$40.00 per property).

<b>TOTAL FEES ENCLOSED =</b>	<b>\$1,020.00</b>
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	<b>Amount to be: Refunded</b>
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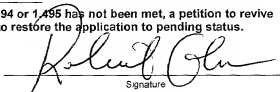
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**NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.**

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## DESCRIPTION

## VIDEO PROCESSING APPARATUS AND METHOD AND MEDIUM

## Technical Field

5           The invention relates to video processing apparatus and method and a medium and, more particularly, to video processing apparatus and method and a medium which are suitable when they are used to decode a compressed video signal.

## 10           Background Art

15           In recent years, a video compressing technique represented by MPEG (Moving Picture Experts Group) 2 has been progressed and used in various fields. In case of decoding video data encoded by MPEG2, the decoding is performed every macroblock. When the video data which was decoded every macroblock is stored in a frame memory, memory addresses of the video data are sequentially allocated in a screen display order. That is, in case of a picture plane  
20           such that a Y macroblock constructed by  $16 \times 16$  pixels as shown in Fig. 1A consists of  $720 \times 480$  pixels, the macroblocks are stored in the frame memory in a state where 45 macroblocks are arranged in the lateral direction and 30 macroblocks are arranged in the  
25           vertical direction as shown in Fig. 1B.

          In case of allocating the memory addresses and storing the video data as mentioned above, such an

allocation is a suitable address allocation in case of displaying the video data onto a screen on the basis of the video data stored in the frame memories. For example, in the frame memory shown in Fig. 1A, when one line in the top portion of the screen is displayed, since the data in addresses 0000 to 0719 (the data as much as 720 pixels) can be continuously read out, the occurrence of a page mishit can be minimized. The "pagemis" denotes a time which is necessary to precharge a sense amplifier provided in a memory such as a DRAM (Dynamic Random Access Memory) or the like (therefore, a process such as reading of the data or the like cannot be performed while precharging).

A DRAM is generally used as a frame memory. The DRAM is constructed by rows and columns and one row is constructed by charge accumulating devices comprising 256 (there is also a case of 512 or the like)  $\times$  8 columns. Among the charge accumulating devices, an 8-bit device has external terminals of 8 pins and a 16-bit device has external terminals of 16 pins. It indicates the number of bits which can be outputted by one clock. In case of the 8-bit device, 8 bits are outputted by one clock. In case of the 16-bit device, 16 bits are outputted by one clock. Data can be continuously extracted in the same row. That is, in the 8-bit device, since data of  $256 \times 8$  bits has been accumulated in one row, data of 256 clocks (data of 256

bytes) can be continuously read out.

In a video decoder or the like, video data which is stored in a frame memory is transmitted on a macroblock unit basis and a decoding order is also set to a macroblock order. In one Y macroblock, one line is constructed by 16 lines each consisting of 16 pixels (therefore, 16 bytes). Therefore, for example, in case of the first Y macroblock, the addresses are divided (instead of serial addresses) in a manner such that addresses 0000 to 0015 are allocated to the first line, addresses 0720 to 0735 are allocated to the second line, and addresses 1440 to 1455 are allocated to the third line, and the data is stored.

In case of decoding a stream of a digital video signal from a stream of the MPEG system, a process for detecting a sequence header (Sequence Header) is first performed in an analyzing unit in a decoding apparatus. This is because unless the Sequence\_Header is detected, a picture size and an aspect ratio cannot be specified.

That is, in the MPEG stream, there is a case where a picture plane of the SDTV (Standard Definition Television) or a picture plane of the HDTV (High Definition Television) is transmitted. For example, in a digital satellite broadcasting, there is a case where a program of a picture plane of the SDTV and a program of a picture plane of the HDTV are multiplexed and

broadcasted in one channel. There is also a case where a channel of a program of a picture plane of the SDTV and channel of a program of a picture plane of the HDTV are switched.

5                   In case of decoding the MPEG stream, first, it is necessary to set a picture size and an aspect ratio. In the MPEG system, a sequence layer has been determined as a most significant layer. In one sequence, a picture size and a picture rate are identical. A Sequence\_Header is transmitted at the head of each sequence. The picture size, aspect ratio, picture rate, and the like have been described in the Sequence\_Header.

10                   Therefore, hitherto, in case of decoding a bit stream of the MPEG system, first, in order to set the picture size and aspect ratio, the Sequence\_Header is detected. After the picture size and aspect ratio were set from the Sequence\_Header, a decoding is started from the first picture which was intrafield encoded or intraframe encoded.

15                   After the data stored in one row was extracted, the process advances to the next row and an apparatus has to wait for a time of about 6 clocks for precharging until the data stored in the next row is read out. In this way, the precharge necessary to read out the data stored in another row is called "pagemis" as mentioned above. In the foregoing 8-bit device, the

pagemis occurs every 256 clocks (each time the data of 256 bytes is extracted). In the foregoing 16-bit device, the pagemis occurs every 128 clocks. It will be understood that, as mentioned above, when an amount of data which can be extracted by one clock increases, the number of times of occurrence (generating period) of the pagemis decreases.

As shown in Fig. 1B, in the case where the video data is stored and the data is sequentially read out one line by one and displayed in a manner such that the data in addresses 0000 to 0719 is read out to thereby display the first horizontal line and the data in addresses 0720 to 1439 is subsequently read out to thereby display the second horizontal line, a pagemis occurs every 256 bytes in the 8-bit device. Since the pagemis causes a loss time, the ability of a memory (DRAM) can be made the most of by setting in such a manner that the pagemis does not occur as possible.

In case of the foregoing video recorder, the video data is stored on a macroblock unit basis and read out on a macroblock unit basis. Since one Y macroblock is constructed by 16 lines as mentioned above, the pagemis occurs each time one line is read out. That is, the pagemis occurs 16 times whenever one Y macroblock is read out. In case of a chroma signal (Cb, Cr), since one macroblock is constructed by 8 lines each consisting of 8 bytes, the pagemis occurs 8

times whenever one Cb (Cr) macroblock is read out.

In case of using the 16-bit device for the frame memory, since the data of 16 bits (2 bytes) can be outputted in response to one clock, the pagemis occurs at a rate of once per 8 clocks in the Y macroblock. In each of the Cb macroblock and the Cr macroblock, the pagemis occurs at a rate of once per 4 clocks. Therefore, 8 clocks (one line of the Y macroblock is constructed by 16 bytes) are necessary to read out one line of the Y macroblock and  $8 \times 16$  clocks (one Y macroblock is constructed by 16 lines) are necessary to read out one Y macroblock.

On the other hand, assuming that a time of 6 clocks is expended for the pagemis of one time, it will be understood that the loss time that is caused by the pagemis is equal to the time of  $6 \times 16$  clocks because the pagemis occurs 16 times in case of reading out one Y macroblock. This means that the ratio of the pagemis is fairly larger than the time ( $8 \times 16$  clocks) which is necessary to read out one Y macroblock. In other words, it means that the loss time is large. Also in case of the macroblock of chroma, the ratio of the loss time for the time that is necessary to read out the data is similarly large.

The pagemis also occurs in case of performing the decoding based on the motion compensation. That is, although the video data as much as one macroblock



is extracted from an arbitrary position in the frame memory by a motion vector associated for the macroblock to be decoded, since the address is moved by an amount of one line each time one line of the macroblock is read out in a manner similar to the case mentioned above, the pagemis occurs. There is a problem such that if the user wants to make the most of the ability of the DRAM or the like, it is necessary to suppress the loss time such as a pagemis as small as possible.

The invention is made in consideration of such a circumstance and it is an object of the invention to suppress the occurrence of the pagemis by allocating addresses to video data of macroblocks in the ascending order and storing the data.

In case of decoding the MPEG stream, first, the Sequence\_Header is detected and the picture size and aspect ratio are set. However, if the MPEG stream is decoded after the Sequence\_Header was detected, there is a problem such that it takes time to detect the Sequence\_Header and a fairly long waiting time is necessary until the reproduction is started.

That is, the sequence layer of the MPEG system is a stream in which the picture size and picture rate are identical. Although the Sequence Header can be provided at a minimum GOP (Grop Of Picture) period, a period of the Sequence\_Header is not determined. Therefore, a maximum length of sequence is

equivalent to one video program. Thus, hitherto, for example, when a channel of a satellite broadcasting is switched, there is a case where it takes time to detect the Sequence\_Header and a fairly long waiting time is necessary until the reproduction is started.

Another object of the invention is to provide video processing apparatus and method in which when Sequence\_Header information of an MPEG stream is not detected, information of the Sequence\_Header is predicted and a decoding is started, thereby enabling the MPEG stream to be immediately decoded.

#### Disclosure of Invention

According to the invention, there is provided a video processing apparatus comprising: input means for inputting video data of a macroblock unit; storage means for allocating addresses to the video data inputted by the input means in an ascending order and storing the video data; and reading means for reading out the video data stored in the storage means in the ascending order of the addresses.

According to the invention, there is provided a video processing method comprising: an inputting step of inputting video data of a macroblock unit; a storing step of allocating addresses to the video data inputted by the inputting step in an ascending order and storing the video data; and a reading step of reading out the video data stored by the storing step in the ascending

order of the addresses.

According to the invention, there is provided a program of a medium, comprising: an inputting step of inputting video data of a macroblock unit; a storing step of allocating addresses to the video data inputted by the inputting step in an ascending order and storing the video data; and a reading step of reading out the video data stored by the storing step in the ascending order of the addresses.

In the video processing apparatus, video processing method, and medium according to the invention, the addresses are allocated to the inputted video data of the macroblock unit in the ascending order, the data is stored, and the stored video data is read out in the ascending order of the addresses.

According to the invention, there is provided a video processing apparatus for decoding a video stream having a layer structure constructed by a sequence layer, a GOP layer, a picture layer, a slice layer, a macroblock layer, and a block layer, comprising: Sequence\_Header information predicting means for predicting Sequence\_Header information on the basis of information which certainly appears in a picture; and decoding means for decoding video data by using the information predicted by the Header information predicting means when the Sequence\_Header is not detected.

The fourth byte of a Slice\_Start\_Code indicates a vertical position of a slice. Therefore, the number of pixels in the vertical direction of a screen is obtained by detecting the fourth byte of the Slice\_Start\_Code. A (Macroblock\_Address\_Increment) indicates skip information of the macroblock. Therefore, the number of macroblocks in the horizontal direction of the screen is obtained by accumulating the macroblock address increment each time the macroblock is decoded. By multiplying it by a size of macroblock, the number of pixels in the horizontal direction of the screen is obtained.

If the MPEG stream is decoded by using the information predicted as mentioned above, the MPEG stream can be immediately decoded without detecting the Sequence\_Header.

#### Brief Description of Drawings

Figs. 1A and 1B are diagrams for explaining a conventional method of storing video data; Fig. 2 is a block diagram showing a construction of an embodiment of a video processing apparatus to which the invention is applied; Fig. 3 is a block diagram showing a detailed construction of a decoding unit 12 in Fig. 2; Fig. 4 is a diagram for explaining a method of storing video data according to the invention; Fig. 5 is a diagram for explaining a method of storing the video data according to the invention; Fig. 6 is a diagram

for explaining a reading of a predictive macroblock;  
Fig. 7 is a block diagram of an example of an MPEG  
decoding apparatus to which the invention is applied;  
Fig. 8 is a schematic diagram for use in explanation of  
5 a layer structure of the MPEG system; Fig. 9 is a  
schematic diagram for use in explanation of slices;  
Fig. 10 is a functional block diagram showing a  
construction of a predicting circuit of a picture size  
in the horizontal direction; Fig. 11 is a schematic  
10 diagram for use in explanation of a macroblock; Fig. 12  
is a functional block diagram showing a construction of  
a predicting circuit of a picture size in the vertical  
direction; Fig. 13 is a block diagram showing a  
construction of an embodiment of an audio decoder 100;  
15 Fig. 14 is a diagram for explaining an example of a  
message which is transmitted from a message  
transmitting program to a decoding program; Figs. 15A  
and 15B are diagrams for explaining a dummy block 131  
and a BBB chain 132 in a memory 114; Fig. 16 is a  
20 flowchart for explaining the processing operation of  
the decoder 100; and Figs. 17A to 17C are diagrams for  
explaining media.

#### Best Mode for Carrying Out the Invention

Fig. 2 is a block diagram showing a  
25 construction of a video processing apparatus for  
decoding data encoded by the MPEG2 system. Video data  
received by a tuner 1 is demodulation processed by a

demodulation processing unit 2 and error correction  
processed by an error correction processing unit 3.  
Further, the error correction processed video data is  
sent to a software processing unit 4. The software  
processing unit 4 is constructed by a software program  
which is executed by a CPU (Central Processing Unit)  
(not shown). A demultiplexer unit 11 in the software  
processing unit 4 demultiplexes the inputted data into  
the video data and audio data every channel. The  
demultiplexed video data is decoded by a decoding unit  
12 on the basis of the MPEG system.

In a display processing unit 13, an output of  
the decoding unit 12 is scanning line number converted,  
for example, from a high definition television signal  
represented by the HDTV to a television signal of the  
NTSC (National Television System Committee) system. A  
controller 14 controls each unit of the software  
processing unit 4 besides the decoding unit 12 and uses  
a cache memory 7 at an arbitrary time with respect to  
processes of the video data. A DMAC (Direct Memory  
Access Controller) 6 controls a DMA transfer from the  
cache memory 7 to a frame memory 5. The frame memory 5  
is constructed by, for example, a DRAM and the stored  
video data is outputted to a video display apparatus  
(not shown).

Fig. 3 is a block diagram showing a more  
detailed construction of the decoding unit 12 shown in

Fig. 2. The video data outputted from the demultiplexer unit 11 is inputted to a variable length decoding unit 31 in the decoding unit 12. The variable length decoding unit 31 performs a variable length decoding process to the inputted video data, outputs a quantization step and the video data to an inverse quantizing unit 32, and outputs a motion vector to a motion compensation predicting unit 35, respectively. On the basis of the quantization step supplied from the variable length encoding unit 31, the inverse quantizing unit 32 inversely quantizes the video data which was variable length encoding processed. The inversely quantized video data is stored in the cache memory 7 through the controller 14.

In case of an intra-macroblock, the video data which was inverse DCT transformation processed by an inverse DCT transforming unit 33 is transferred and stored as it is to the cache memory 7. In case of a nonintra-macroblock, the motion compensation predicting unit 35 arithmetically operates a predictive macroblock by using the motion vector supplied from the variable length decoding unit 31 and a reference video image stored in the frame memory 5 and the video data is stored in the cache memory 7. An arithmetic operating unit 34 adds the video data (differential data) supplied from the inverse DCT transforming unit 33 and the predictive macroblock supplied from the cache

memory 7 to thereby obtain decoded video data and transfers it to the cache memory 7. The video data stored in the cache memory 7 is DMA transferred to the frame memory 5 on the basis of a control of the DMAC 6.

5           The operation of the video decoding apparatus shown in Fig. 2 will now be described. The tuner 1 receives the video data and outputs it to the demodulation processing unit 2. The demodulation processing unit 2 which received the video data  
10 demodulation processes the inputted video data and outputs it to the error correction processing unit 3. The error correction processing unit 3 performs an error correcting process of the video data which was inputted and demodulation processed and outputs it to  
15 the software processing unit 4. In the software processing unit 4, the inputted video data is demultiplexed to the video data and audio data every channel by the demultiplexer unit 11 and they are outputted to the decoding unit 12.

20           The decoding unit 12 is controlled by the controller 14, decodes the video data by arbitrarily using the cache memory 7 and frame memory 5, and outputs the decoded video data to the display processing unit 13. The display processing unit 13  
25 performs a scanning line number converting process to the decoded video data and stores it into the frame memory 5. The video data stored in the frame memory 5,



namely, the video data subjected to the scanning line number converting process is outputted to a video display apparatus (not shown) or the like.

The writing of the video data into the frame memory 5 in the decoding unit 12 shown in Fig. 3 will be described. The writing of the data into the frame memory 5 and the reading of the data from the frame memory 5 are performed on a macroblock unit basis. Since one Y macroblock is constructed by  $16 \times 16$  pixels, it is constructed by the data of 256 bytes. Each of the Cb macroblock and the Cr macroblock is constructed by 64 ( $= 8 \times 8$ ) bytes. Therefore, as shown in Fig. 4, as for the Y macroblocks, continuous addresses are sequentially allocated in the ascending order and those macroblocks are stored in a manner such that the Y macroblock which is read for the first time and located on the left top side on the screen is stored in addresses 0000 to 0255 in the frame memory 5, the Y macroblock which is subsequently read is stored in addresses 0256 to 0511, and further, the Y macroblock which is subsequently read is stored in addresses 0512 to 0768.

Similarly, as shown in Fig. 5, as for the chroma macroblocks of the Cb macroblocks and the Cr macroblocks, continuous addresses are sequentially allocated in the ascending order and those macroblocks are stored in a manner such that the chroma macroblock

which is read for the first time is stored in addresses 0000 to 0063 and the chroma macroblock which is subsequently read is stored in addresses 0064 to 0128.

By storing the video data of the macroblock unit as mentioned above, the pagemis never occurs in both of the Y macroblock and the Cb (Cr) macroblock at the time of reading out one macroblock. That is, the pagemis occurs when the row as a target to be read out is switched, and one row is constructed by 256 bytes (hereinafter, properly, 256 bytes are called one page and a delimiter of each unit is called a page delimiter). Therefore, the pagemis occurs at least every reading operation of 256 bytes. However, if the data is stored in the frame memory 5 as mentioned above, the page delimiter is generated every macroblock with respect to the Y macroblock. The page delimiter is generated every 4 macroblocks with respect to the Cb (Cr) macroblock.

Since it is sufficient to reduce the number of times of switching of the row in order to minimize the pagemis (loss time), the loss time can be reduced by storing the data into the frame memory 5 as mentioned above.

Explanation will now be made with respect to the case of extracting the predictive video data by the motion compensation vector from the frame memory 5 in which the video data has been stored. The case where

the Y macroblock is set to a target will be described as an example. As mentioned above, one Y macroblock is constructed by  $16 \times 16$  pixels ( $16 \times 16$  bytes).

Fig. 6 is a diagram showing a positional relation of a macroblock MA<sub>n</sub> (macroblock which is decoded) to be predicted from a macroblock MA<sub>m</sub> by predicting a picture plane which is displayed on a screen of the screen display apparatus. Among motion compensation vectors of MA<sub>n</sub>, the motion compensation vector in the lateral (horizontal) direction in the diagram is expressed by a vector x and the motion compensation vector in the longitudinal (vertical) direction in the diagram is expressed by a vector y. The vectors x and y are used for deciding address offsets in the horizontal and vertical directions by which the data should be extracted from the upper left edge portion of the macroblock MA<sub>m</sub>.

A case where the macroblock MA<sub>m</sub> whose position is unconditionally determined by the vectors x and y overlaps with up to four macroblocks as shown in Fig. 6 is predicted. If those four macroblocks are described by a macroblock MA<sub>0</sub>, a macroblock MA<sub>1</sub>, a macroblock MA<sub>2</sub>, and a macroblock MA<sub>3</sub> in order from the upper left to the lower right, relations between the macroblock MA<sub>n</sub> to be decoded and the vectors x and y are as shown by the following equations.

$$MA_0 = MA_n + x/16 + MA_w \times y/16$$

$$MA_1 = MA_0 + 1$$

$$MA_2 = MA_0 + MA_w$$

$$MA_3 = MA_0 + MA_w + 1$$

..... (1)

5           where, x and y denote magnitudes of the  
vectors x and y and MA\_w indicates the number of  
macroblocks arranged on a line in the horizontal  
direction of the screen.

10           Further, the addresses (head addresses) at  
the upper left edges in the portions of the macroblocks  
MA\_0, MA\_1, MA\_2, and MA\_3 which overlap with the  
macroblock MA\_m are calculated by the following  
equations. The head addresses of the macroblocks MA\_0,  
MA\_1, MA\_2, and MA\_3 are assumed to be addresses ad\_0,  
15       ad\_1, ad\_2, and ad\_3, respectively.

$$ad_0 = ad_{MA_0} + x\%16 + 16x(y\%16)$$

$$ad_1 = ad_{MA_1} + 16x(y\%16)$$

$$ad_2 = ad_{MA_2} + x\%16$$

$$ad_3 = ad_{MA_3}$$

..... (2)

20           where, ad\_MA\_0, ad\_MA\_1, ad\_MA\_2, and ad\_MA\_3 denote  
head addresses of the macroblocks MA\_0, MA\_1, MA\_2, and  
MA\_3, x%16 denotes a remainder obtained when the  
magnitude of the vector x is divided by 16, and  
25       similarly, y%16 denotes a remainder obtained when the  
magnitude of the vector y is divided by 16.

The number of horizontal data and the number

of vertical lines in the portions of the macroblocks MA  
0, MA\_1, MA\_2, and MA\_3 which overlap with the  
macroblock MA\_m are calculated by the following  
equations. In the following equations, MA\_0\_h denotes  
5 the number of horizontal data in the overlapped portion  
of the macroblock MA\_m and the macroblock MA\_0 and MA\_0  
v denotes the number of vertical lines in the  
overlapped portion of the macroblock MA\_m and the  
macroblock MA\_0. The other descriptions also indicate  
10 similar meanings.

$$\begin{aligned} \text{MA}_0\text{\_h} &= 16 - (x\%16), & \text{MA}_0\text{\_v} &= 16 - (y\%16) \\ \text{MA}_1\text{\_h} &= 16 - \text{MA}_0\text{\_h}, & \text{MA}_1\text{\_v} &= \text{MA}_0\text{\_v} \\ \text{MA}_2\text{\_h} &= \text{MA}_0\text{\_h}, & \text{MA}_2\text{\_v} &= 16 - \text{MA}_0\text{\_v} \\ \text{MA}_3\text{\_h} &= \text{MA}_1\text{\_h}, & \text{MA}_3\text{\_v} &= \text{MA}_2\text{\_v} \\ & & \text{..... (3)} \end{aligned}$$

As mentioned above, in case of extracting the  
data from the four macroblocks MA\_0, MA\_1, MA\_2, and MA  
3, the pagemis occurs four times. In case of  
extracting the data from the same macroblock (one  
20 macroblock), no pagemis occurs. That is, there is a  
possibility such that the pagemis occurs at least 0  
time and at most four times.

However, two banks are provided in the DRAM  
or the like and the writing or reading of the data is  
25 performed by switching the banks. In the macroblock,  
the data is alternately written in the different banks  
every horizontal line. Therefore, in case of

performing the writing by using two banks 0 and 1 as shown in Fig. 6, the following processes are repeated: namely, the data of one horizontal line of the macroblock MA\_0 is read out from the bank 0; the data of one horizontal line of the macroblock MA\_2 is read out from the bank 1; the data of one horizontal line of the macroblock MA\_1 is read out from the bank 0; and subsequently, the data of one horizontal line of the macroblock MA\_3 is read out from the bank 1.

If the data is read out by switching the banks 0 and 1 as mentioned above, the pagemis does not occur. That is, since each of the banks 0 and 1 has an independent sense amplifier, it can be independently set to an active state (precharging state). Therefore, even if the macroblocks stored in the other bank are continuously read out (even if the data is read out by switching the banks), the pagemis (loss time) due to the switching can be ignored. Thus, only the pagemis which occurs when the data of the macroblock MA\_0 is first read out becomes the loss time.

Although the case of reading out the Y macroblock has been described above in the equations (1) to (3), in case of the chroma (Cb, Cr) macroblocks, it is sufficient to calculate by replacing 16 with 8 in each equation.

By writing and reading the video data as mentioned above, a time which is required for data

transfer in the time necessary for reading out one Y macroblock is equal to  $8 \times 16$  clocks. Assuming that the time of one pagemis is equal to 6 clocks, the loss time due to the pagemis is equal to  $6 \times 1$  clocks, so that the ratio of the loss time due to the pagemis to the time for data transfer can be reduced. Similarly, even in case of reading out one Cb (Cr) macroblock, the ratio of the loss time due to the pagemis to the time for data transfer can be reduced.

Processes in case of outputting the video data to the video display apparatus (not shown) will now be described. In the case where the video data of the macroblock unit was stored in a manner such that a data arrangement on the screen and a data arrangement in the frame memory are the same as shown in Fig. 1B, the video display is performed by reading out the data in the ascending order of the addresses. However, in case of storing the macroblocks by one or two lines as shown in Fig. 4 (Fig. 5), a video image cannot be displayed by reading out the data in the ascending order of the addresses.

In other words, in the case where the video data was stored as shown in Fig. 1B, the video data of 16 pixels (16 bytes) is read out from each macroblock in order to display one line on the screen. Even in the case where the video data was stored as shown in Fig. 4 (Fig. 5), the video data of every 16 bytes has

to be similarly read out from each macroblock. By this method, the row has to be switched each time 16 bytes are read out and the pagemis occurs each time. To eliminate such an inconvenience, it is sufficient to perform an address conversion and output the video data to the video display apparatus as shown below.

The cache memory 7 shown in Fig. 3 is used as a temporary buffer and the video data of one slice is loaded into the cache memory 7 from the frame memory 5 and converted into a memory structure (address) as shown in Fig. 1B. In case of using an SRAM (Static RAM) as a cache memory 7, since no page exists like a DRAM, no pagemis occurs.

A case of converting the addresses from the state where the Y macroblocks have been stored as shown in Fig. 4 to a state where the Y macroblocks have been stored as shown in Fig. 1B will be specifically described. The video data in addresses 0000 to 0015 is read out as video data of the first line from the frame memory 7 in which the video data has been stored as shown in Fig. 4 and is stored in addresses 0000 to 0015 in the cache memory 7. Then, the video data in addresses 0016 to 0031 is read out as video data of the second line and stored in addresses 0720 to 0735 in the cache memory 7. Subsequently, the video data in addresses 0032 to 0047 is read out as video data of the third line and stored in addresses 1440 to 1455 in the



cache memory 7. Such processes are repeated.

In case of reading out the video data from the frame memory 7 as mentioned above, since the reading operation itself is executed in the ascending order of the addresses, the pagemis occurs only every 256 bytes. The video data stored in the cache memory 7 is transferred again to the frame memory 5 and stored. The video data stored in the frame memory 5 as shown in Fig. 1B is outputted to the video display apparatus (not shown).

Since the re-transfer from the cache memory 7 to the frame memory 5 is performed in the address order of the one-to-one corresponding relationship, if the cache memory 7 is constructed by the SRAM, no pagemis occurs, so that the loss time due to the above processes does not occur.

Although the video data is transferred again from the cache memory 7 to the frame memory 5 in the above description, it can be also transferred from the cache memory 7 to a frame memory (DRAM) for displaying or scaling which is different from the frame memory 5.

By writing and reading the video data of the macroblocks as mentioned above, the macroblocks obtained after completion of the decoding can be sequentially stored in the same page in the frame memory comprising the DRAM or the like. Therefore, the number of times of occurrence of the pagemis can be

reduced by using a burst transfer function of the DRAM and a memory band width can be improved. Since the macroblocks have been stored in the same page in the frame memory, even in case of extracting a reference macroblock by the motion compensation vector, the number of times of occurrence of the pagemis can be reduced by using a burst transfer of the DRAM and a memory band width can be improved.

When the macroblocks are stored in the frame memory, by alternately storing them into the other bank in the DRAM every horizontal width of the screen, even in case of extracting the predictive data from a plurality of (up to four) macroblocks, the pagemis can be minimized. Further, since the memory can be constructed by two banks, a structure of the memory system can be simplified and also realized by a DRAM of a small (less) capacity, so that flexibility is high.

A video processing apparatus in which when the Sequence\_Header information of the MPEG stream is not detected, the information of Sequence\_Header is predicted and the decoding is started, thereby enabling the MPEG stream to be immediately decoded will now be described. Fig. 7 shows an example of the video processing apparatus to which the invention is applied. In Fig. 7, the MPEG stream from the demultiplexer 11 is supplied to the MPEG decoder 12 and supplied to a Sequence\_Header predicting circuit 16. The MPEG

decoder 12 executes a decoding process of the MPEG stream.

5       The MPEG stream is decoded by the MPEG decoder 12 and a stream of the digital video data is outputted from the MPEG decoder 12. An output of the MPEG decoder 12 is supplied to a display 15 through the display processing unit 13. Thus, a picture plane based on the MPEG stream is displayed on the display 15.

10       In the case where the MPEG stream is decoded by the MPEG decoder 12, first, it is necessary to set a picture size, an aspect ratio, or the like. Those information can be detected by the Sequence\_Header. However, there is a case where it takes time to detect the Sequence\_Header.

15       Therefore, the Sequence\_Header predicting circuit 16 is provided. The Sequence\_Header predicting circuit 16 predicts the information to be transmitted by the Sequence\_Header by using the information which is certainly included in each picture.

20       That is, in the Sequence\_Header, the information such as picture size, aspect ratio, frame rate, VBV buffer size, quantization matrix, and the like is sent. The Sequence\_Header predicting circuit 25       16 predicts the picture size in the vertical direction by using the information of slices. The picture size in the horizontal direction is predicted by using the

information of the macroblock. The aspect ratio is predicted by using the picture size in the vertical direction and the picture size in the horizontal direction which were predicted. By detecting a decoding timing by a time stamp of DTS/PTS or the like, the frame rate is predicted. An output of the Sequence Header predicting circuit 16 is supplied to the MPEG decoder 12 and supplied to the display processing unit 13.

In case of decoding the MPEG stream by the MPEG decoder 12, if the Sequence\_Header can be detected, the picture size, aspect ratio, frame rate, VBV buffer size, quantization matrix, progressive sequence, and the like are set by using the information of the Sequence\_Header.

When the Sequence\_Header cannot be detected by the MPEG decoder 12, the picture size, aspect ratio, frame rate, VBV buffer size, quantization matrix, progressive sequence, and the like which were predicted by the Sequence\_Header predicting circuit 16 are set.

When the Sequence\_Header cannot be detected by the MPEG decoder 12, the picture size and aspect ratio which were predicted by the Sequence\_Header predicting circuit 16 are transmitted to the display processing circuit 13. A display screen is set in accordance with the picture size and aspect ratio which were predicted by the Sequence\_Header predicting

circuit 16.

In the MPEG decoding apparatus to which the invention is applied as mentioned above, the Sequence Header predicting circuit 16 for predicting the information of the Sequence\_Header is provided. When the Sequence\_Header cannot be detected, a decoding process is performed by using the picture size and aspect ratio predicted by the Sequence\_Header predicting circuit 16. Therefore, for example, even when the channels are switched in the satellite broadcasting, there is hardly a waiting time and the reproduction can be started.

A principle and a construction of the Sequence\_Header predicting circuit 16 will now be specifically explained.

As shown in Fig. 8, a data structure of the MPEG is a layer structure of a sequence layer, a GOP layer, a picture layer, a slice layer, a macroblock layer, and a block layer.

The sequence layer is a group of picture planes having a series of same attributes, for example, the same picture size and the same video rate. The GOP layer is a group of picture planes serving as a unit of a random access. The picture layer is a group of attributes which are common to one picture plane. The slice layer is a group obtained by finely dividing one picture plane. The macroblock layer is a group

obtained by further finely dividing the slice layer and is a group for performing a motion vector detection or the like. The block layer is a block itself for performing a DCT transformation.

5           A Sequence\_Header (SH) is provided at the head of the sequence. In the Sequence\_Header, the following items are described.

- (1) Horizontal\_Size\_Value: the number of pixels in the horizontal direction of the video image
- (2) Vertical\_Size\_Value: the number of pixels in the vertical direction of the video image
- (3) Aspect\_Ratio\_Information: aspect ratio
- 15   (4) Frame\_Rate\_Code: display period of the video image
- (5) VBV\_Buffer\_Size: capacity of a virtual buffer for controlling a generation code amount (VBV)
- 20   (6) Load\_Quantization\_Matrix: quantization matrix for macroblocks
- (7) Progressive\_Sequence: showing a progressive scan

And the like.

25           Among them, the information of the number of pixels in the vertical direction of the video image (Vertical\_Size\_Value) can be predicted from the

information of slices.

That is, Fig. 9 shows a construction of slices in one picture. As shown in Fig. 9, one picture is divided into a plurality of slices. The slice at the leftmost edge of the top stage ( $B_s = 1$ ) in one picture is set to Slice (1, 0). The second slice from the left of the top stage is set to Slice (1, 1). In a manner similar to the above, the slice at the leftmost edge of the bottom stage ( $B_s = N$ ) in one picture is set to Slice (N, 0). The second slice from the left of the bottom stage is set to Slice (N, 1).

Although a plurality of slices can exist in the horizontal direction as mentioned above, the slice is certainly switched to the slice which has a new slice ID as a start code at the left edge of the picture. Therefore, a size in the vertical direction of one picture can be predicted by using the slice.

That is, a Slice\_Start\_Code as a sync code indicative of the start of the slice layer is inserted at the head of each slice. The Slice\_Start\_Code is shown by "00 00 01 01 ~ AF" of a hexadecimal number. Last one byte ("01 ~ AF" of the fourth byte) of the code indicates the vertical position of the slice by the hexadecimal number. As mentioned above, the 4th byte of the Slice\_Start\_Code corresponds to the position in the vertical direction of the slice and this means the same number in the same line.

From the above explanation, the number of pixels in the vertical direction of the screen can be predicted by detecting the 4th byte of the Slice\_Start Code at the bottom stage in one picture.

Fig. 10 is a functional block diagram showing a construction for predicting the number of pixels in the vertical direction of the screen from the information of the slice as mentioned above. In Fig. 10, the MPEG stream is supplied to an input terminal 41. A Picture\_Start\_Code in the MPEG stream is detected by a Picture\_Start\_Code detecting unit 42. A Slice\_Start\_Code is detected by a Slice\_Start\_Code detecting unit 43.

The Picture\_Start\_Code is a code showing the start of the picture layer. The Slice\_Start\_Code is a code showing the start of the slice layer. The 4th byte of the Slice\_Start\_Code indicates the vertical position.

An output of the Slice\_Start\_Code detecting unit 43 is sent to a 4th byte extracting unit 44. In the 4th byte extracting unit 44, the information of the 4th byte of the Slice\_Start\_Code is extracted. An output of the 4th byte extracting unit 44 is sent to a vertical size register 45.

The head of one picture can be detected by detecting the Picture\_Start\_Code by the Picture\_Start Code detecting unit 42. When the head of one picture



is detected, the vertical size register 45 is reset.  
Whether the Slice\_Start\_Code has been detected by the  
Slice\_Start\_Code detecting unit 43 or not is  
discriminated.

5                In the case where the Slice\_Start\_Code is  
detected by the Slice\_Start\_Code detecting unit 43, the  
information of the 4th byte of the Slice\_Start\_Code is  
extracted by the 4th byte extracting unit 44 and the  
information of the 4th byte of the Slice\_Start\_Code is  
10               supplied to the register 45. Until the next Picture  
Start\_Code is detected by the Picture\_Start\_Code  
detecting unit 42, when the Slice\_Start\_Code is  
detected by the Slice\_Start\_Code detecting unit 43, the  
information of the 4th byte of the Slice\_Start\_Code is  
15               extracted by the 4th byte extracting unit 44 and the  
register 45 is updated on the basis of this value.

                 When the next Picture\_Start\_Code is detected  
by the Picture\_Start\_Code detecting unit 42, the  
information in the register 45 is inputted as  
20               information of the number of pixels in the vertical  
direction into a vertical size register 46.

                 The Slice\_Start\_Code is detected from the  
head to the end of the picture by the Slice\_Start\_Code  
detecting unit 43 in this manner, and when the Slice  
25               Start\_Code is detected, the value of the 4th byte is  
extracted by the 4th byte extracting unit 44 and  
inputted to the vertical size register 45, so that a

predictive value of the number of pixels in the vertical direction is derived from the value in the vertical size register 46.

The number of pixels in the horizontal direction of the video image (Horizontal\_Size\_Value) can be predicted from the information of the macroblocks. That is, as shown in Fig. 11, the macroblocks are obtained by further dividing the slice. In this example, there are macroblocks MB1, MB2, and MB3 in a Slice (1, 0) and there are macroblocks MB4, MB5, MB6, and MB7 in a Slice (1, 1). The skipped macroblocks exist between the macroblocks MB2 and MB3 of the Slice (1, 0).

A Macroblock\_Address\_Increment is provided at the head of the macroblock and it is a VLC (variable length code) indicative of the macroblocks to be skipped. Although the Macroblock\_Address\_Increment is equal to "1" in the ordinary adjacent macroblocks, when the macroblocks to be skipped exist, it is set to a value increased by the number of skipped macroblocks.

The value of the Macroblock\_Address\_Increment in one slice, therefore, is accumulated every macroblock, and in the case where a plurality of slices exist in the horizontal direction, by adding the accumulated values of the Macroblock\_Address\_Increment in each slice, the number of macroblocks in the lateral direction per picture plane can be recognized. By

multiplying the recognized number by the size of macroblock, namely, "16" with respect to the luminance signal or "8" with regard to the two color difference signals, the number of pixels in the horizontal direction per picture can be predicted.

Fig. 12 is a functional block diagram showing a construction for predicting the number of pixels in the horizontal direction of the picture plane from the information of the macroblock as mentioned above.

In Fig. 12, the MPEG stream is supplied to an input terminal 51. The Slice\_Start\_Code in the MPEG stream is detected by a Slice\_Start\_Code detecting unit 52 and the Macroblock\_Address\_Increment is detected by a Macroblock\_Address\_Increment detecting unit 53.

In case of predicting the number of pixels in the horizontal direction, irrespective of the first Picture Coding Type, the decoding is performed in the MPEG decoder 12 by an intra-process only in such a picture. When the decoding of the macroblock is performed, a signal indicating that the decoding of the macroblock has been performed is outputted. The signal indicating that the decoding of the macroblock has been performed is supplied from an input terminal 62 to a decoding macroblock detecting unit 57.

In the case where the slice at the leftmost edge of one line is detected by the Slice\_Code detecting unit 52, register 55, registers 58A, 58B,

..., and a horizontal size register 61 are cleared. In the Macroblock\_Address\_Increment detecting unit 53, the Macroblock\_Address\_Increment is detected.

The Macroblock\_Address\_Increment indicates skip information of the macroblocks and increment values corresponding to "1" to "33" are written by variable length codes. When the Macroblock\_Address\_Increment is equal to or larger than "33", a Macroblock Escape is also referred to.

An output of the Macroblock\_Address\_Increment detecting unit 53 is supplied to a VLC decoding unit 54. The value of the Macroblock\_Address\_Increment is decoded in the VLC decoding unit 54.

An output of the VLC decoding unit 54 is supplied to an adder 56. An output of the register 55 is supplied to the adder 56. An output of the decoding macroblock detecting unit 57 is supplied to the register 55. When the fact that the decoding of the macroblocks has been performed is detected from the output of the decoding macroblock detecting unit 57, the value of the present Macroblock\_Address\_Increment and that of the previous Macroblock\_Address\_Increment are added in the adder 56 and the values of the Macroblock\_Address\_Increment are accumulated. The accumulated value of the Macroblock\_Address\_Increment in each slice of the same horizontal line is consequently obtained.

The output of the register 55 is supplied to the registers 58A, 58B, .... In the case where there are a plurality of slices in the horizontal direction, the registers 58A, 58B, ... fetch the accumulated value of the Macroblock\_Address\_Increment in each slice. An output of the Slice\_Start\_Code detecting unit 52 is supplied to the registers 58A, 58B, .... The accumulated value of the Macroblock\_Address\_Increment is inputted every slice into the registers 58A, 58B, ... in response to the output of the Slice\_Start\_Code detecting unit 52. For example, the accumulated value of the Macroblock\_Address\_Increment in the first slice of the same horizontal line is inputted to the register 58A. The accumulated value of the Macroblock\_Address\_Increment in the next slice of the same horizontal line is inputted to the register 58B.

Outputs of the registers 58A, 58B, ... are supplied to an adder 59. In the adder 59, the accumulated value of the Macroblock\_Address\_Increment in each slice is added. As mentioned above, by adding the value of the Macroblock\_Address\_Increment accumulated in each slice, the number of macroblocks in the lateral direction per picture plane can be obtained.

An output of the adder 59 is supplied to a multiplier 60. The multiplier 60 multiplies the number of macroblocks by the size of macroblock, thereby

calculating the number of pixels in the horizontal direction. That is, in the multiplier 60, by multiplying the number of macroblocks by the size in the horizontal direction of macroblock, the number of pixels in the horizontal direction per picture is calculated. The number of pixels in the horizontal direction obtained in this manner is supplied to the horizontal size register 61.

As mentioned above, in the adder 56 and register 55, the value of the Macroblock\_Address Increment in one slice is accumulated every macroblock, and the value of the Macroblock\_Address\_Increment accumulated in each slice is added by the adder 59, so that the number of macroblocks in the lateral direction per picture plane is calculated. In the multiplier 60, it is multiplied by the size of macroblock, so that the number of pixels in the horizontal direction per picture is obtained.

The aspect ratio (Aspect\_Ratio\_Information) can be predicted on the basis of the number of pixels in the horizontal direction and the number of pixels in the vertical direction of the video image which were obtained as mentioned above. If the picture size is equal to  $(720 \times 480)$ , the TV type is the SDTV. Therefore, it is predicted that the aspect ratio is equal to  $(4 : 3)$ . If the picture size is equal to  $(920 \times 1080)$ , the TV type is the HDTV. Therefore, it is

predicted that the aspect ratio is equal to (16 : 9).

A display period (Frame\_Rate\_Code) of the video image is indirectly predicted by recognizing the decoding timing by the time stamp of the DTS/PTS or the like.

As for the size (Vbv\_Buffer\_Size) of the virtual buffer (Vbv) for controlling the generation code amount, the buffer having the maximum size in the possible level profile is prepared. Similarly, also with respect to the decoding video image, the capacity of the ordinary possible maximum size in the relevant level profile is assured.

A quantization matrix for macroblocks (Load Quantization\_Matrix) is substituted by a default value.

A Progressive\_Sequence is substituted by Progressive\_Frame in the Picture\_Coding\_Type which is multiplexed every frame.

Although the case of decoding the stream of the MPEG1 or MPEG2 system has been described in the above example, the invention can be also similarly applied to the case of decoding a stream of a similar layer structure.

The decoding of the MPEG video stream by the software has been described above. A decoding of an MPEG audio stream by software will now be described hereinbelow. In an MPEG audio decoder, MPEG audio data which is supplied from the outside is decoded by a

decoding module, the decoded data is supplied to a  
codec module, it is digital/analog converted by the  
codec module, and the converted analog data is  
outputted to an external apparatus.

5           However, when the MPEG audio data decoded by  
the decoding module is outputted to the codec module,  
if a channel of the MPEG audio data is switched, the  
data before the switching of the channels is outputted  
for a predetermined time, so that it is inconvenient.

10           Therefore, in the audio decoder by the  
software in the invention, muting data is outputted  
from the decoding module to the codec module at the  
time of channel switching.

15           Fig. 13 is a block diagram showing a  
construction of an embodiment of an audio decoder 100.

20           The user inputs desired information by  
operating an input unit 111. For example, by operating  
the input unit 111, the user turns "ON" a power source  
of the decoder 100, switches the channels of MPEG audio  
data which is supplied from the outside, or instructs  
the muting.

25           A CPU 112 reads out programs stored in  
memories 115 to 117, which will be explained  
hereinlater, and executes the programs on the basis of  
the information supplied from the input unit 111. A  
data change-over switch 113 switches the MPEG audio  
data and program data. The MPEG audio data which is



supplied from the outside is inputted to a memory 114 through a DMA (Direct Memory Access) bus 120 and the data change-over switch 113 and stored.

5 An AC link program linked with the power source has been stored in the memory 115. When the user turns "ON" the power source of the decoder 100 through the input unit 111, the CPU 112 reads out the AC link program through the data change-over switch 113 and executes it.

10 A message transmitting program which corresponds to the information inputted from the input unit 111 and is used for transmitting a message has been stored in the memory 116. This message is transmitted to a decoding program and a data transfer processing program stored in the memory 117, which will be explained hereinlater. That is, when the user inputs desired information through the input unit 111, the CPU 112 reads out the message transmitting program through the data change-over switch 113, executes it, and transmits the message corresponding to the inputted information to the decoding program and the data transfer processing program.

20 The decoding program for decoding the MPEG audio data stored in the memory 114 at a timing of the supplied message and the data transfer processing program have been stored in the memory 117. The CPU 112 decodes the MPEG audio data stored in the memory

114 at the timing of the message which is supplied and allows the data obtained after completion of the decoding to be stored again in the memory 114.

Subsequently, the CPU 112 reads out and executes the data transfer processing program and transfers the MPEG audio data obtained after completion of the decoding and stored in the memory 114 to an output buffer 118. At the time of the power source "ON", the channel switching, and the muting instruction, dummy data (data of "0") which has previously been stored in the memory 114 is transferred to the output buffer 118.

The data temporarily stored in the output buffer 118 is supplied to a codec 119 through the DMA bus 120. The codec 119 digital/analog converts the supplied MPEG audio data obtained after completion of the decoding and outputs the converted data to an external apparatus (not shown) through the DMA bus 120.

Subsequently, an example of the message which is transmitted from the message transmitting program in response to the decoding program and the data transfer processing program will now be described with reference to Fig. 14.

First, when the power source is turned "ON" (at time t1) by the user through the input unit 111, a "U" message is transmitted to the decoding program and the data transfer processing program. The "U" message is used for showing that the power source has been

turned on. A "W" message is subsequently transmitted to the decoding program and the data transfer processing program for a predetermined time (T2). The "W" message shows "wait for decoding" and T2 denotes the time which is required until the MPEG audio data of a predetermined amount is stored in the memory 14.

When the MPEG audio data of the predetermined amount is stored in the memory 114, an "F" message is transmitted to the decoding program and the data transfer processing program. The "F" message indicates "start the decoding". When this message is received, the CPU 112 starts the decoding of the MPEG audio data stored in the memory 114. After that, an "N" message is transmitted to the decoding program and the data transfer processing program (T3). The "N" message indicates "continue the decoding". The CPU 112 continues the decoding in accordance with this message.

When the user operates the input unit 111 and switches the channel, the "W" message is transmitted to the decoding program and the data transfer processing program for a predetermined time (T5). The CPU 112 waits until the new MPEG audio data is decoded. T5 denotes the time which is required until the MPEG audio data of a predetermined amount obtained after completion of the channel switching is stored in the memory 114.

When the MPEG audio data of the predetermined

amount is stored in the memory 114, the "F" message is transmitted to the decoding program and the data transfer processing program. The CPU 112 starts the decoding of the MPEG audio data. After that, the "N" message is transmitted to the decoding program and the data transfer processing program (T6). The CPU 112 continues the decoding.

When the user operates the input unit 111 and turns "OFF" the decoder 100 (time t7), a "D" message is transmitted to the decoding program and the data transfer processing program. The decoding of the MPEG audio data is finished.

Subsequently, a function such that the CPU 112 switches the data which is transferred from the memory 114 to the output buffer 118 on the basis of the message will be described with reference to Fig. 15.

Fig. 15A shows a dummy block 131 which has previously existed in the memory 114. "0" data has been stored in the dummy block 131. Fig. 15B shows a BBB chain 132 in which the MPEG audio data obtained after completion of the decoding is stored. The BBB chain 132 is constructed by six blocks of an (a) block 141 to an (f) block 146 and stores the MPEG audio data obtained after completion of the decoding in order from the (a) block 141.

In the case where the "W" message is transmitted (for example, time T2 and time T5 in Fig.

14) from the message transmitting program in response to the data transfer processing program, the CPU 112 reads out the "0" data from the dummy block 131 in the memory 114 and transfers the read-out "0" data to the output buffer 118. Thus, at the time of turn "ON" of the power source and the channel switching, the muting data is outputted to the codec 119 for a predetermined time.

When the "F" message or "N" message is transmitted (for example, time T3 and time T6 in Fig. 14) from the message transmitting program in response to the data transfer processing program, the CPU 112 reads out the data obtained after completion of the decoding in order from the (a) block 141 of the BBB chain 132 in the memory 114 and transfers the read-out data to the output buffer 118. Thus, the data after the decoding is outputted to the codec 119 while the MPEG audio data is being decoded.

Subsequently, the processing operation in the case where when the power source of the decoder 100 is turned on, the CPU 112 switches the data to be transferred from the memory 114 to the output buffer 118 on the basis of the message will be described with reference to a flowchart of Fig. 16.

First, in step S11, when the user operates the input unit 111 and turns "ON" the power source of the decoder 100, the CPU 112 reads out the AC link

program from the memory 115 and executes it.

Subsequently, in step S12, the CPU 112 reads out the message transmitting program from the memory 116 and executes it. At this time, the "U" message indicative of the turn "ON" of the power source is transmitted to the decoding program and the data transfer processing program.

In step S13, the "W" message indicative of the waiting for the start of the decoding is transmitted to the decoding program and the data transfer processing program.

In step S14, the CPU 112 reads out the "O" data from the dummy block 131 in the memory 114 and transfers the data to the output buffer 118.

In step S15, the CPU 112 discriminates whether the MPEG audio data of the predetermined amount has been stored in the memory 114 or not. In step S15, if it is determined that the MPEG audio data of the predetermined amount is not stored in the memory 114, the processing routine is returned to step S13. The subsequent processes are repetitively executed.

In step S15, if it is determined that the MPEG audio data of the predetermined amount has been stored in the memory 114, the processing routine advances to step S16. The "F" message indicative of the start of the decoding is transmitted to the decoding program and the data transfer processing

program.

In step S17, the CPU 112 starts the decoding of the MPEG audio data stored in the memory 114 and stores the decoded data into the BBB chain 132 in the memory 114.

In step S18, the CPU 112 reads out the decoded data from the BBB chain 132 in the memory 114 and transfers the data to the output buffer 118.

In step S19, the CPU 112 discriminates whether all of the MPEG audio data has been decoded or not. In step S19, if it is decided that all of the MPEG audio data is not decoded, the processing routine is returned to step S16 and the subsequent processes are repetitively executed. In step S19, if it is decided that all of the MPEG audio data has been decoded, the processing operation is finished.

A medium which is used for installing a program to execute the foregoing series of processes into a computer and setting a state where they can be executed by the computer will now be described with reference to Fig. 17.

As shown in Fig. 17A, the program can be provided to the user in a state where it has previously been installed in a hard disk 152 or a semiconductor memory 153 as a recording medium built in a personal computer 151 (corresponding to a video decoding apparatus).

Otherwise, as shown in Fig. 17B, the program can be provided as package software in a state where it is temporarily or permanently stored in a recording medium such as floppy disk 161, CD-ROM 162, MO disk 163, DVD 164, magnetic disk 165, semiconductor memory 166, or the like.

Further, as shown in Fig. 17C, the program can be also provided in a manner such that it is transferred from a download site 171 to a personal computer 173 through a satellite 172 in a wireless manner or transferred to the personal computer 173 through a network 181 such as local area network or Internet in a wired or wireless manner and is downloaded to a built-in hard disk or the like in the personal computer 173.

The "medium" in the specification denotes a broad concept including all of those media.

In the video processing apparatus, video processing method, and medium according to the invention, the addresses are allocated to the inputted video data of the macroblock unit in the ascending order, the video data is stored, and the stored video data is read out in the ascending order of the addresses. Therefore, the number of times of occurrence of the pagemis can be suppressed.

According to the video processing apparatus and method of the invention, when the Sequence\_Header



is not detected, the 4th byte of the Slice\_Start\_code  
is detected, the number of pixels in the vertical  
direction of the picture plane is predicted, the value  
of the Macroblock\_Address\_Increment is accumulated, the  
5 number of macroblocks in the horizontal direction of  
the picture plane is obtained, it is multiplied by the  
size of macroblock, and the number of pixels in the  
horizontal direction of the picture plane is predicted.  
The decoding of MPEG is performed by using the  
10 information predicted as mentioned above. Thus, the  
MPEG stream can be immediately decoded even if the  
Sequence\_Header is not detected.

#### Industrial Applicability

15 The invention is suitable for use in decoding  
of the video signal compressed by MPEG.

CLAIMS

1. A video processing apparatus comprising:  
input means for inputting video data of a  
macroblock unit;  
5 storage means for allocating addresses to  
said video data inputted by said input means in an  
ascending order and storing said video data; and  
reading means for reading out said video data  
stored in said storage means in the ascending order of  
10 the addresses.
2. A video processing apparatus according to  
claim 1, further comprising:  
conversion storage means for converting said  
15 video data read out by said reading means into the data  
of an address arrangement similar to that of a video  
image which is displayed on the basis of said video  
data and storing said video data.
3. A video processing apparatus according to  
claim 1, wherein said storage means has two or more  
20 banks, switches said banks every width in the  
horizontal direction of a video image which is  
displayed on the basis of said video data, and stores  
said video data.
4. A video processing method comprising:  
25 an inputting step of inputting video data of  
a macroblock unit;  
a storing step of allocating addresses to

said video data inputted by said inputting step in an ascending order and storing said video data; and

a reading step of reading out said video data stored in said storing step in an ascending order of the addresses.

5. A medium for allowing a computer to execute a program, wherein said program comprises:

an inputting step of inputting video data of a macroblock unit;

a storing step of allocating addresses to said video data inputted by said inputting step in an ascending order and storing the video data; and

a reading step of reading out said video data stored by said storing step in the ascending order of the addresses.

6. A video processing apparatus for decoding a video stream having a layer structure constructed by a sequence layer, a GOP layer, a picture layer, a slice layer, a macroblock layer, and a block layer, comprising:

Sequence\_Header information predicting means for predicting Sequence\_Header information on the basis of information which certainly appears in a picture; and

decoding means for decoding video data by using the information predicted by said Header information predicting means when said Sequence\_Header

is not detected.

7. A video processing apparatus according to claim 6, wherein said Sequence\_Header information predicting means includes vertical pixel number predicting means for predicting the number of pixels in the vertical direction of a picture plane from information in a slice.

8. A video processing apparatus according to claim 6, wherein said Sequence\_Header information predicting means includes horizontal pixel number predicting means for predicting the number of pixels in the horizontal direction of a picture plane from information in a macroblock.

9. A video processing apparatus according to claim 6, wherein said Sequence\_Header information predicting means includes aspect ratio predicting means for predicting the number of pixels in the vertical direction of a picture plane from information in a slice, predicting the number of pixels in the horizontal direction of the picture plane from information in a macroblock, and predicting an aspect ratio of the picture plane from said predicted number of pixels in the vertical direction and said predicted number of pixels in the horizontal direction.

10. A video processing method of decoding a video stream having a layer structure constructed by a sequence layer, a GOP layer, a picture layer, a slice

layer, a macroblock layer, and a block layer,  
comprising the steps of:

predicting Sequence\_Header information on the  
basis of information which certainly appears in a  
5 picture; and

decoding video data by using said predicted  
information when said Sequence\_Header is not detected.

11. A video processing method according to claim  
10, wherein when said Sequence\_Header information is  
10 predicted, the number of pixels in the vertical  
direction of a picture plane is predicted from  
information in a slice.

12. A video processing method according to claim  
10, wherein when said Sequence\_Header information is  
15 predicted, the number of pixels in the horizontal  
direction of a picture plane is predicted from  
information in a macroblock.

13. A video processing apparatus according to  
claim 10, wherein when said Sequence\_Header information  
20 is predicted, the number of pixels in the vertical  
direction of a picture plane is predicted from  
information in a slice, the number of pixels in the  
horizontal direction of the picture plane is predicted  
from said number of pixels in the vertical direction  
25 and said number of pixels in the horizontal direction  
and an aspect ratio of the picture plane is predicted.

# ABSTRACT

One macroblock is constructed by  $16 \times 16$  pixels (bytes). When the macroblocks are stored in a frame memory constructed by a DRAM or the like, addresses are sequentially allocated in an ascending order in a manner such that addresses 0000 to 0255 are allocated to the first macroblock and addresses 0256 to 0512 are allocated to the second macroblock and the macroblocks are stored. The macroblocks stored in this manner are read out in the ascending order of the addresses.

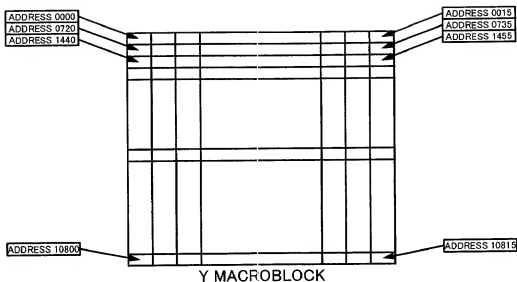
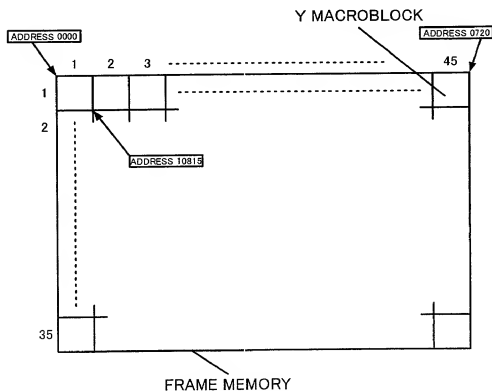
**Fig. 1A****Fig. 1B**

Fig. 2

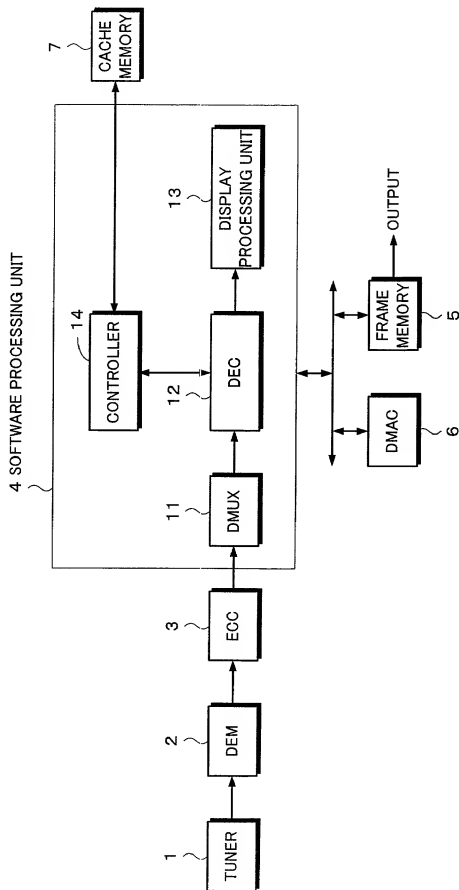




Fig. 3

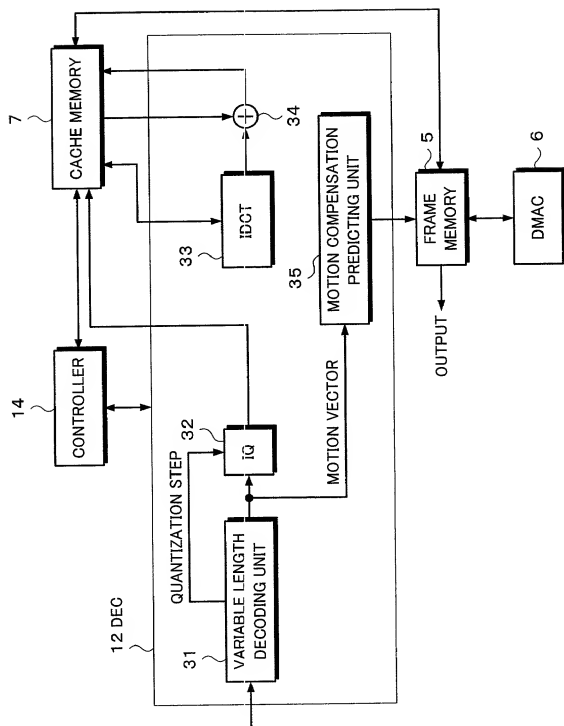


Fig. 4

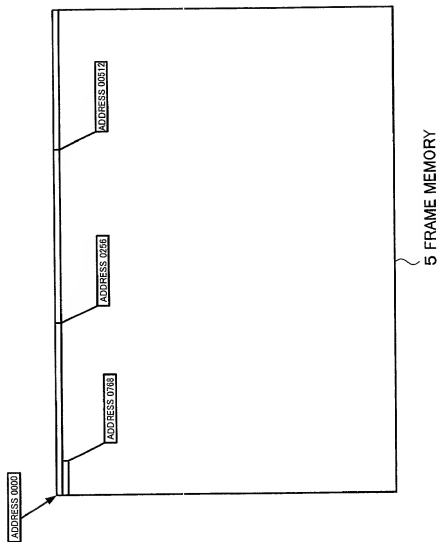
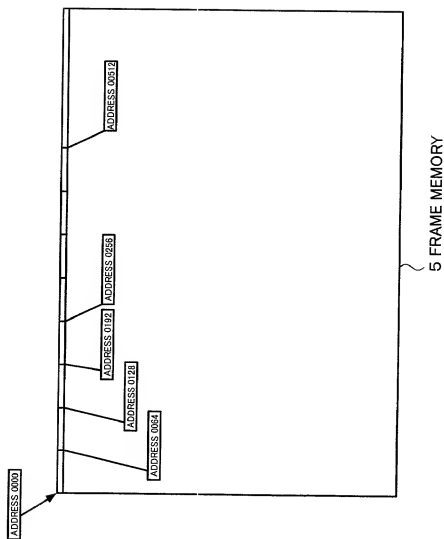


Fig. 5



109720 26461760

Fig. 6

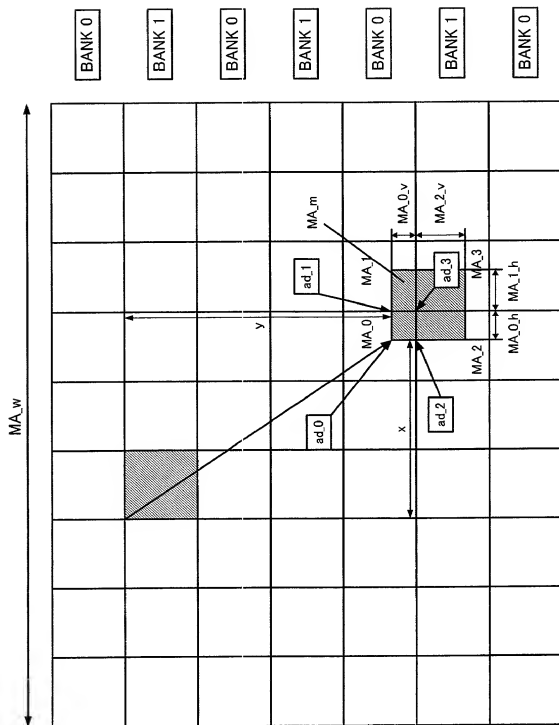
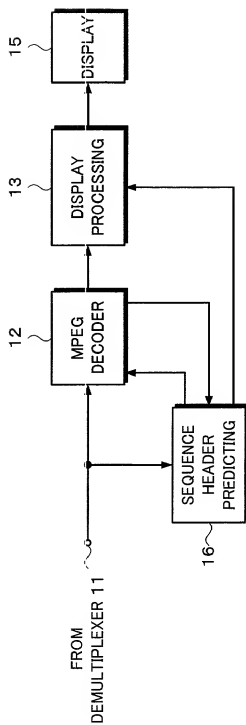


Fig. 7

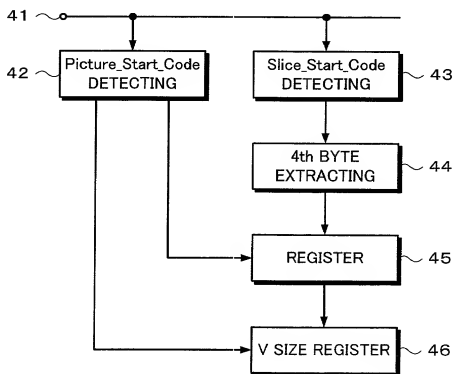


The diagram illustrates the hierarchical structure of a video frame, showing the relationship between different layers:

- SEQUENCE LAYER:** The top layer, showing a sequence of frames. A frame is labeled "I" (Intra-coded) or "P" (Predictor-coded). A frame is labeled "I" if it is the first frame in a GOP (Group of Pictures).
- GOP LAYER:** A Group of Pictures (GOP) is shown, consisting of a sequence of frames. A frame is labeled "I" (Intra-coded) or "P" (Predictor-coded). A frame is labeled "I" if it is the first frame in a GOP.
- PICTURE LAYER:** A single frame is shown, divided into slices. A slice is a contiguous sequence of macroblocks. A slice is labeled "SLICE".
- SLICE LAYER:** A single slice is shown, divided into macroblocks. A macroblock is a unit of processing. A macroblock is labeled "MB".
- MACROBLOCK LAYER:** A single macroblock is shown, divided into four sub-blocks. The sub-blocks are labeled ①, ②, ③, and ④. The sub-blocks are labeled "Cb" (Chroma Blue) and "Cr" (Chroma Red).
- BLOCK LAYER:** A single block is shown, divided into four sub-blocks. The sub-blocks are labeled ①, ②, ③, and ④. The sub-blocks are labeled "Y" (Luminance) and "Cb" (Chroma Blue).

**Fig. 9**

Bs=1	Slice (1,0)		Slice (1,1)	
Bs=2	Slice (2,0)		Slice (2,1)	
Bs=3	Slice (3,0)	Slice (3,1)		Slice (3,2)
Bs=N	Slice (N,0)		Slice (N,1)	

**Fig. 10**

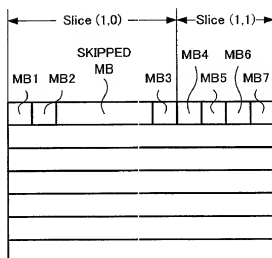
**Fig. 11**



Fig. 12

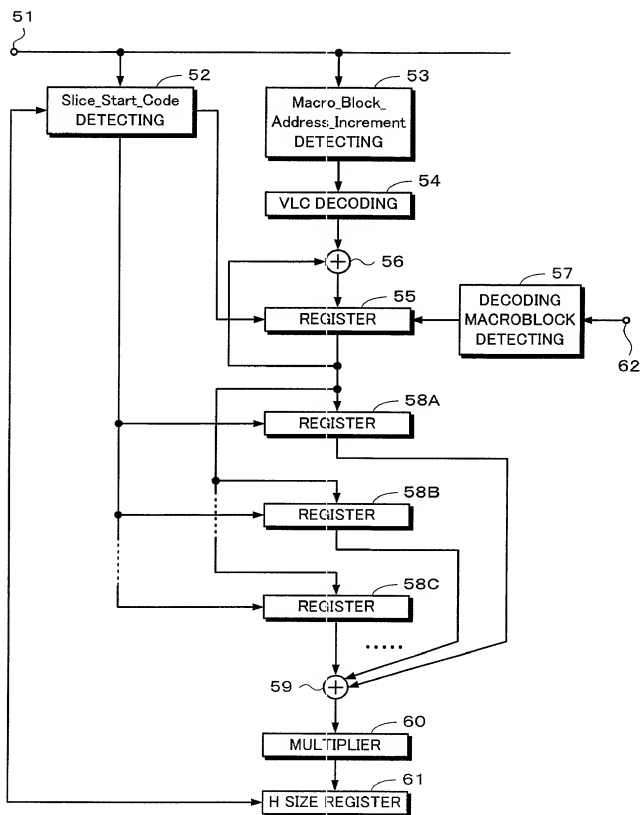


Fig. 13

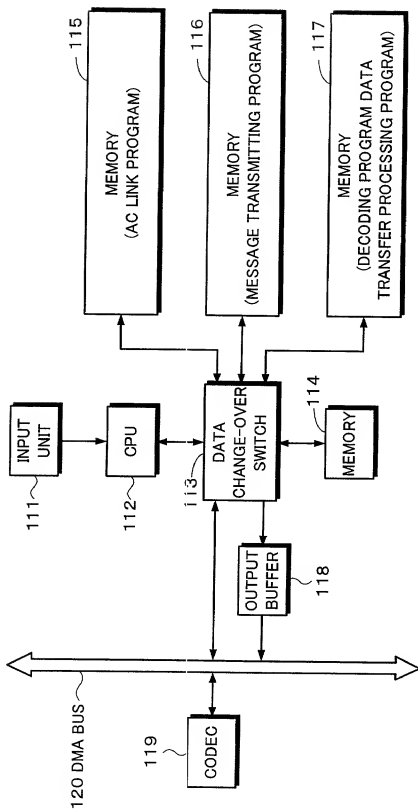
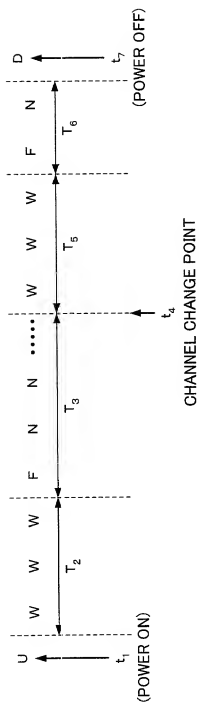


Fig. 14



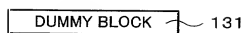
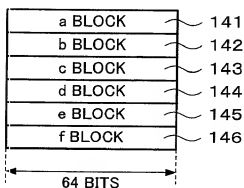
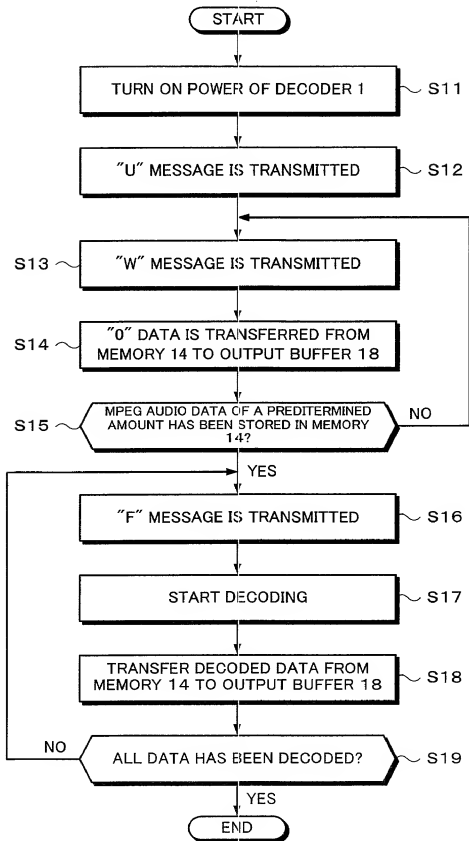
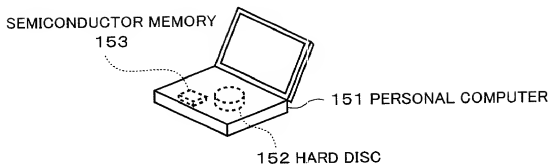
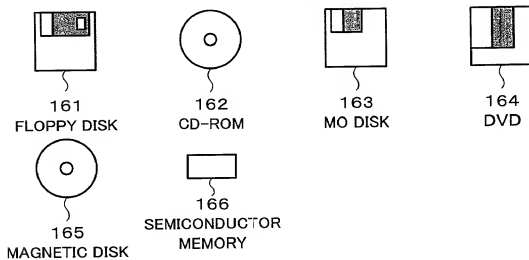
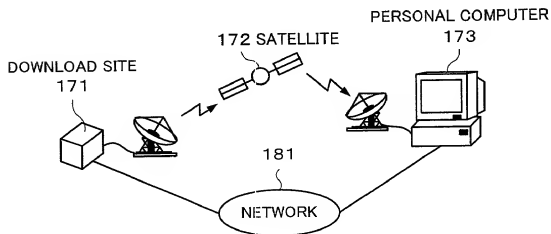
**Fig. 15A****Fig. 15B**BBB CHAIN 132

Fig. 16



**Fig. 17A****Fig. 17B****Fig. 17C**

- 5.. FRAME MEMORY
- 12.. MPEG DECODER
- 16.. SEQUENCE HEADER PREDICTING CIRCUIT
- 42.. PICTURE\_START\_CODE DETECTING UNIT
- 43.. SLICE\_START\_CODE DETECTING UNIT
- 46.. VERTICAL SIZE REGISTER
- 52.. SLICE\_START\_CODE DETECTING UNIT
- 53.. MACROBLOCK\_ADDRESS\_INCREMENT DETECTING UNIT
- 61.. HORIZONTAL SIZE REGISTER

PTO/SB/106 (8-96)

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My residence, post office address and citizenship are as stated next to my name.

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I believe: I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

VIDEO PROCESSING APPARATUS

AND METHOD AND MEDIUM

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## Prior Foreign Application(s)

外国での先行出願

P11-105255

(Number)

P11-122647

(番号)

(Number)

(番号)

Japan

(Country)

Japan

(国名)

(Country)

(国名)

I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Priority Not Claimed

優先権主張なし

13 April 1999

(Day/Month/Year Filed)

(出願年月日)

28 April 1999

(Day/Month/Year Filed)

(出願年月日)

☒ Listing of Foreign Applications  
Continued on Page 4

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(出願番号)

(Filing Date)

(出願日)

(Status: Patented, Pending, Abandoned)

(現況: 特許許可済、係属中、放棄済)

(Application No.)

(出願番号)

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(出願日)

(Status: Patented, Pending, Abandoned)

(現況: 特許許可済、係属中、放棄済)

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

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(Supply similar information and signature for third and subsequent joint inventors.)

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<u>Number</u>	<u>Country</u>	<u>(Day/Month/Year Filed)</u>	<u>Priority Not Claimed</u>
P11-153797	<u>Japan</u>	01 June 1999	<input type="checkbox"/>
	<u>Japan</u>		<input type="checkbox"/>

3-00 Declaration and Power of Attorney For Patent Application -- Additional Inventors

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Fourth Inventor's signature \_\_\_\_\_ Date \_\_\_\_\_

Residence:

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Post Office Address:

Full name of fifth joint inventor, if any (given name, family name):

Fifth Inventor's signature \_\_\_\_\_ Date \_\_\_\_\_

Residence

Citizenship:

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